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**The Mouth Parts of COPRIS CAROLINA; with notes
on the homologies of the mandibles.***

BY JOHN B. SMITH, SC. D.

Copris carolina is the largest of our eastern *Coprophagus* *Scarabæidæ*, and is not rare if the habits are known. It forms, for some purposes, a good species for class work, and I made a rather careful study of the mouth-parts, preliminary to its use for that purpose. I cannot remember having seen a complete study of a similar mouth, and the present paper may, therefore, contain some things not generally known.

The food of this insect is found in the comparatively soft and fresh excrement of cattle, and the sense of taste would seem rather a useless one, not requiring excessive development of gustatory structures under the circumstances. Yet, the organs usually credited with such functions are here well marked. The food being soft and pasty, strongly developed mandibles are not needed, and, indeed, at first sight they seem entirely absent. Our classification correctly says, however, that they are present, and are partly membranous.

In homologizing the head parts of an insect, the mandibles, maxilla and labium, have each been called modified appendages to separate segments, the head itself being made up of a number variously estimated from four to seven. In most insects the maxilla is the most complex organ and contains the largest number of distinct sclerites. It is with this that we must compare other structures where either division has not been carried so far, or where consolidation has been necessary. The labium is quite usually a more or less completely united organ with a single pair of appendages, and in no form yet known to me is the organ entirely divided or completely "paired." All main parts of the maxilla have been identified in the labium, and Prof. Comstock, in his "Introduction," has given an excellent summary of the relation of the parts of each to the other.

The mandibles are always separated or paired, and, though they may be rudimentary or entirely wanting, I remember no case in which they unite. That they are composed of more than one sclerite is well known, and Kirby and Spence have named one of the pieces the prostheca. Prof. Comstock also calls attention to this fact, and

* This paper in its essential features was presented to Section F, of the A. A. A. S., at the Washington meeting, August, 1891, and charts containing enlarged copies of the figures herewith given, were used to illustrate the paper.

figures a compound mandible without attempting to name the parts or to homologize its sclerites with those of other appendages.

In many of the Lamellicorns, the divisions become well marked with proper treatment, and the homologies are, I think, fairly evident. In *Copris carolina* they are not so distinct as in some other species, but they will answer my present purpose. Reference should be made to fig. 4, of Pl. II, where the pieces are named in accordance with the following explanation: At the base, outwardly, is a large, corneous sclerite, to which are attached, inferiorly, most of the muscles and tendons controlling the entire organ. This may be called the *basalis*, or basal piece, and it is the homologue of the *stipes* in the maxilla. There is, in some species, an intermediate piece between the basalis and the head, which represents the *cardo* of the maxilla, and which I propose to call the *sub-basalis*, or tendon bearer; the former on account of its position, the latter as expressive of function. The muscular attachment is, however, to the basalis as well as to the sub-basalis even when the latter is present. Another of the basal pieces, united to the basalis and forming the inner inferior part of the entire organ, I propose to call the *molar*, or grinder. I believe it to be homologous with the subgalea, and the function is expressed by the names. The food is not cut or broken by any other organ, and indeed needs little cutting. But to get into the gullet it must pass between these grinders and is there fitted for swallowing. In the present species the molars are ridged and dissimilar. The one grinding face is convex, the other is concave; the convex surface fitting accurately into the opposite concavity.

In *Macroductylus*, *Cetonia* and some other genera, these molars are much larger, proportionately, fitted for scraping as well as for grinding or chewing. Between the molar, which is always well chitinated in all the forms I have seen, and a flattened, more membranous piece, also attached to the basalis, is a small sclerite which I have thus far found in *Copris* only; and this I call the *conjunctivus*, or connecting piece. It has no other function that I can find, and does not seem to occur where there is a greater development of the molar. It most likely represents the basal joint of the galea, and is obscured where the molar is largely developed. The flat, membranous piece forming most of the inner and part of the outer margin of the mandibles toward the tip, is the homologue of the galea, and I have called it the *terebra*, or piercer. In this species it is quite closely united to the basalis, and is fringed with long, dense and fine hair.

In some other species, notably the Cetoniids and pollen-feeding forms, it is entirely distinct and separate, much firmer in texture, though also fringed with hair. In those cases the attachment is seen to be much more to the grinder than to the basalis, and the connection between the two is distinctly evident, which is not the case here. It is this piece, which, when hardened and united with the other parts of the mandible, forms the apical acute tooth, and justifies the term "terebra." Arising from the same base as this piercer is another small piece, also membranous and fringed with hair, quite closely united to the terebra. This is the *prostheca* of Kirby and Spence, and is homologous to the lacinia of the maxilla. In some Staphylinidæ it becomes more prominent, and in some Passalidæ it is modified into a moveable tooth above the basal or molar grinding surface. There are not, so far as I know, any true appendages to the mandibles. By this explanation it is seen that the structure of the mandible is fundamentally the same as that of the labium and maxilla, and that we have an equally complex organ in point of origin. Its usual function, however, demands a powerful and solid structure, and the sclerites are in most instances so thoroughly chitinized and so closely united to the others, that practically there is only a single piece, in which the homology is obscured.

There is nothing peculiar or worthy of remark in the maxillary structure. The sclerites are all well marked, and the galea is very densely clothed with brownish hair on a spongy surface (see fig. 5, Pl. II).

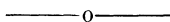
The epipharynx is most remarkably developed in this insect, as indeed it is in many others of the Lamellicorns. In dissecting out the mouth parts from the macerated head after the labial and maxillary structures have been removed, a cutting of all other membranous tissue will release the mandibles and epipharynx, united as shown in figures 1 and 2, of Pl. II. The union is not intimate, and the parts are shown in connection to give a better idea of their relative position and size. At Pl. II, fig. 3, the *epipharynx*, seen from below, is separately figured to bring out its structural features more in detail. It lies in the cavity of the head close beneath the upper chitinous surface and moveable within; that is, it is not attached to the walls. In texture it is semi-membranous, roughly shield shaped, the lateral margins inrolled and fringed with hair, which is loosely set into foveæ at the edges. Inwardly it is set with rather short and quite stout, moveable spines, densely massed in the centre, where a

chitinous loop supports and strengthens the organ. It is still further supported by a chitinous band or arch over the top, well shown at fig. 2, Pl. II.

In this species the organ is completely united into a single structure. In *Cetonia* and allies, its paired nature is distinctly evident, and instead of a shield-shaped organ we have two lobes, united at or near base. The function of the hypopharynx is said to be gustatory, and these moveable spines should, therefore, be tactile in character, and also glandular. Of the latter I find no evidence, but my specimens were submitted to a macerating process calculated to destroy all save the chitinized structures, and therefore their absence proves nothing. I have no doubt that further study of this most interesting organ will discover species in which it is completely divided, and in which the sclerites composing it are better marked than in any I have studied.

Placing a prepared head, underside up, before us, we have the appearance shown at fig. 1, Pl. III. The genæ or cheeks, form the extreme lateral margin to the eyes, the gula is central, and above it come in order the submentum, the mentum, all united on the median line, and the broad labial palpi; the latter obscuring all the other labial structures. Cutting through the sutures on either side of the gula so as to release all the parts properly belonging to the labial structures, we have also all that pertains to the gullet, pharynx, or anterior portion of the digestive tract immediately behind the mouth opening. Viewed from the side as shown at fig. 3, Pl. III, we get an excellent idea of what is really the swallowing apparatus of the insect, the parts behind the mentum and submentum corresponding to the fulcrum or sucking stomach of the Diptera. The structure is in large part membraneous, but supported by chitinous rods and bands in such a way as to gain in strength without losing necessary mobility. The ligular structures are seen a little interior and behind the palpi. Turning this structure so as to view it from the innerside, the appearance shown at fig. 2, Pl. III, is presented. The paraglossæ are the most prominent, corneous and concave interiorly, the ligular parts soft, spongy, set densely with fine hair, and united at one margin with the paraglossæ. Whether any portion of this structure should be called hypopharynx I cannot decide, but should think not, unless it be that ligula and paraglossæ are closely welded together, and that what I call ligula, is really hypopharynx. At the base of the ligular structure and interior, is the opening to

the gullet, membranous in structure. Dissecting out this portion and magnifying more highly, we bring into view a narrow, slit-like opening to the gullet or pharynx, guarded in front by a pair of toothed processes, and laterally by a pair of membranous flaps, the function of which is evidently to protect the mouth opening, and probably also to move into it in due order the food prepared by the preceding structures. Removing the toothed structures for still greater magnification, we get quite a formidable appearance shown at fig. 7, Pl. III. The teeth are but little chitinized, and I cannot see that they are mobile. What function they have is still obscure to me.



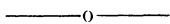
EXPLANATION OF PLATE II.

(*Copris carolina*)



Fig. 1. Mandibles and epipharynx from below.

- " 2. Mandibles and epipharynx from side and above.
- " 3. Epipharynx from below.
- " 4. Mandible—the sclerites named and homologized.
- " 5. Maxilla—the sclerites named.
- " 6. Molars or grinders, opposing faces.
- " 7. Mouth opening with protective membranous flaps.
- " 8. Labial palpi from innerside.



EXPLANATION OF PLATE III.

(*Copris carolina*)



Fig. 1. Head from below, labial structures only.

- " 2. Labial structures from innerside.
- " 3. Labial structures from side.
- " 4. Chitinous framework of labial structures.
- " 5. Section through the labium.
- " 6. Ligula and paraglossæ.
- " 7. Toothed processes shielding mouth opening.



